

1 Attorney Docket No. 60085

2
3 EFFICIENT SNOWMAKING WITH POLYMER DRAG REDUCTION
4

5 STATEMENT OF GOVERNMENT INTEREST

6 The invention described herein may be manufactured and used
7 by or for the Government of the United States of America for
8 governmental purposes without the payment of any royalties
9 thereon or therefore.
10

11 CROSS REFERENCE TO OTHER PATENT APPLICATIONS

12 Not applicable.
13

14 BACKGROUND OF THE INVENTION

15 (1) Field Of The Invention

16 The present invention relates to a method for producing
17 man-made snow and apparatus therefore, and more particularly, to
18 a method for improving the performance of snow making equipment
19 by reducing frictional drag.

20 (2) Description Of The Prior Art

21 Recreational skiing has been on the increase over the years
22 to the point where ski areas must make snow to supplement
23 natural snow, because in many areas of the world not enough
24 natural snow falls to satisfy the demand for good skiing

1 conditions. In recent years, indoor skiing facilities have
2 enjoyed construction everywhere. Consequently, there is a need
3 to produce large amounts of artificial snow.

4 To produce large amounts of artificial snow, a large amount
5 of energy is used to supply the many pumps that are necessary to
6 transfer the water needed to make the snow. Furthermore, large
7 pipes and hoses are required to transport the water making it
8 difficult to set up and move the snow making equipment. In
9 consideration of the large amounts of energy consumed by the
10 pumps, it is important to increase the efficiency of snow making
11 and reduce the energy required to make an amount of snow.

12 Known methods of increasing snow making efficiency have
13 generally focused on increasing the recreational efficiency of
14 the actual snow produced. Many of these methods involve the
15 introduction of nucleating materials such as cellulose and
16 various polymers. While these methods are successful at
17 reducing the quantity of snow necessary, they do not address the
18 large amounts of energy required to actually make the snow.

20 SUMMARY OF THE INVENTION

21 A first object of this invention is to provide a method for
22 increasing efficiency in a snowmaking system.

23 Another object is providing a snowmaking system having
24 reduced input and greater efficiency.

1 Yet another object of this invention is to allow greater
2 dispersal of artificial snow by providing increased muzzle
3 velocity at the snow making nozzle.

4 Accordingly, embodiment of the present invention is a
5 method for making artificial snow comprising the steps of mixing
6 water with a drag reducing polymer to form an aqueous solution;
7 aerating the aqueous solution; and freezing the aerated aqueous
8 solution to form snow crystals. In a preferred embodiment, the
9 drag reducing polymer comprises polyethylene oxide in a carrier
10 solution wherein the carrier solution includes glycerin and
11 isopropanol.

12 In another embodiment, the drag reducing polymer includes
13 polyethylene oxide particles having a diameter less than about
14 20 microns. Preferably, the concentration of the polyethylene
15 oxide in the carrier solution is about 20 to about 30 percent by
16 weight and the concentration of the drag reducing polymer in the
17 water is approximately about 30 to about 100 weight parts per
18 million (WPPM).

19
20 BRIEF DESCRIPTION OF THE DRAWINGS

21 These and other features and advantages of the present
22 invention will be better understood in view of the following
23 description of the invention taken together with the drawings
24 wherein:

FIG. 1 is a schematic view of prior art snowmaking process;
and

FIG. 2 is a schematic view of one embodiment of the present
invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the practice of snow making 10, FIG. 1, a water supply
12, such as a stream, pond, or tank is required for providing a
large supply of water 14 needed for the production of large
quantities of artificial snow 16. A pump 18 is used to draw the
water 14 from the water supply 12, and transport the water 14 up
the mountain through suitable piping 20, to the location 22
where the snow 16 is to be made. A snow gun 24 is positioned,
pointing in the direction that the snow 16 is to be placed.
Water 14 being transported up the hill, through piping 20, can
be directed to the snow gun by the use of various branch lines
coming from various T's in the water pipe 20. In many snow
making operations, the snow guns 24 are connected to hydrants 26
having valves 28 using flexible rubber hoses 30. Compressed air
32 is also commonly employed, however, a fan type of gun (not
shown) may also be used.

In nearly all snow making operations, a large amount of
piping 20 is required because the water supply 12 is far away
from the location 22 where the snow 16 is to be made. The large

1 amount of piping 20 introduces a large amount of frictional drag
2 for the pump 18 to overcome. Consequently, large pumps 18 are
3 required which utilize large amounts of energy to operate.

4 The present invention includes drag reducing polymers 34,
5 FIG. 2, introduced into the water 14 to reduce the frictional
6 drag needed to be overcome by the pump 18, thus reducing the
7 amount of energy required to produce artificial snow 16. The
8 drag reducing polymers 34 reduce the frictional drag of the
9 water 14 as it flows through the piping 20 thus allowing more
10 water 14 to be pumped to the snow maker snow gun 24 or to use
11 smaller diameter piping 20 and/or flexible rubber hoses 30 to
12 produce the same quantity of snow 16. A greater volume of snow
13 can be generated with the same diameter of piping.

14 The drag reducing polymers 34 of the present invention can
15 be used with any snow making process and is not limited to those
16 described above or below. The drag reducing polymers 34 may
17 also be used in combination with other snow making additives 36
18 for example, but not limited to, nucleating particles.
19 Furthermore, the drag reducing polymers 34 may be used in any
20 system wherein water 14 is pumped over large distances, for
21 example, but not limited to, manufacturing processes and heat
22 exchangers.

23 In one embodiment, the drag reducing polymers 34 include
24 small particles of polyethylene oxide suspended in a carrier

1 solution, such as glycerin and isopropanol, at concentrations of
2 approximately 20-30% by weight of the total. According to a
3 preferred embodiment, the polyethylene oxide particles are
4 smaller than 20 microns although larger particles will also
5 work.

6 In a preferred embodiment, the drag reducing polymers 34
7 are placed near the inner wall 36 of the water pipe 20 to
8 further reduce the frictional drag. The drag reducing polymers
9 34 may be introduced into the water 14 using a venturi 38 or a
10 pump 40. Preferably, the drag reducing polymers 34 are
11 introduced into the pipe 20 so that the resulting concentration
12 of the polymer in the water is approximately 30-100 weight parts
13 per million (wppm).

14 In a further preferred embodiment, the drag reducing
15 polymers 34 are introduced into the water 14 as close to the
16 water source 12 as possible. Introducing the drag reducing
17 polymers 34 near the water source 12 maximizes the reduction of
18 frictional drag.

19 According to another embodiment, compressed air 16 is
20 introduced above the polyethylene oxide in place of the pump 40.
21 This is an air over fluid system. The addition of the drag
22 reducing polymers 34 into the water 14 not only reduces the
23 frictional drag required to be overcome by the pump 18, but also
24 makes it easier for persons used to set up the air/water

1 equipment 24 since the flexible rubber hoses 30 required can be
2 smaller in size and easier to manage.

3 Furthermore, the muzzle velocity of the snow 16 out of the
4 gun 24 is increased, allowing the snow 16 to be blown over a
5 greater area.

6 In light of the above, it is therefore understood that
7 within the scope of the appended claims, the invention may be
8 practiced otherwise than as specifically described.